Health Consultation

Paradise Road Well Contamination

Spokane County, Washington

December 1, 2000

Prepared by
The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Foreword

The Washington State Department of Health (DOH) has prepared this Health Consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This Health Consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this Health Consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. The Health Consultation allows DOH to respond quickly to a request from concerned residents for health information on hazardous substances. It provides advice on specific public health issues. DOH evaluates sampling data collected from a hazardous waste site or industrial site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

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Glossary

Acute	Occurring over a short period of time. An acute exposure is one which lasts for less than 2 weeks.
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal pubic health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Aquifer	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate it's theoretical ability to cause cancer in humans. Also known as the cancer potency factor.
Carcinogen	Any substance that can cause or contribute to the production of cancer.
Chronic	A long period of time. A chronic exposure is one which lasts for a year or longer.
Contaminant	Any chemical that exists in the environment or living organisms that is not normally found there.
Dose	A dose is the amount of a substance that gets into the body through ingestion, skin absorption or inhalation. It is calculated per kilogram of body weight per day.
Exposure	Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). Exposure may be short term (acute) or long term (chronic).
Groundwater	Water found underground that fills pores between materials such as sand, soil, or gravel. In aquifers, groundwater often occurs in quantities where it can be used for drinking water, irrigation, and other purposes.
Inorganic	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.

Maximum Contaminant Level (MCL)	A drinking water regulation established by the federal Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.
No public health hazard	Sites for which data indicate no current or past exposure or no potential for exposure and therefore no health hazard.
Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e. dose) below which health effects are not expected. RfDs are published by EPA.
Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
Plume	An area of contaminants in a specific media such as groundwater.
Risk	The probability that something will cause injury, linked with the potential severity of that injury. Risk is usually indicated by a theoretical estimate of how many extra cancers may appear in a group of people who are exposed to a particular substance at a given concentration, in a particular pathway, and for a specified period of time. For example, a 1%, or 1 in 100 risk indicates that for 100 people who may be exposed, 1 person may experience cancer as a result of the exposure.
Route of exposure	The way in which a person my contact a chemical substance that includes ingestion, skin contact and breathing.
U.S. Environmental Protection Agency (EPA)	Established in 1970 to bring together parts of various government agencies involved with the control of pollution.

Background and Statement of Issues

This health consultation was prepared by the Washington State Department of Health (DOH) to assess potential health hazards associated with pesticide contamination detected in three residential drinking water wells located on Paradise Road in Spokane County, Washington. The Washington State Department of Agriculture (WSDA) documented the contamination in a Case Investigation Report (No. 023S-99) released in January 2000 and referred the issue to DOH.[1] DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR)

The contaminated wells are located on Paradise Road approximately five miles northwest of Spangle, Washington (Figure 1). On July 16, 1999, a resident living on Paradise Road (Residence 1) contacted WSDA to complain about potential contamination of her well water after she had noted signs of phytotoxicity in her vegetable and ornamental plants (Figure 2). On July 19, 1999, WSDA inspected Residence 1 and the surrounding area but found no evidence to suggest that a pesticide spill had occurred anywhere on or near the property. Agricultural activity in the area was noted to be "standard small grain - legume rotation that is characteristic of the Palouse region of eastern Washington." A drainage ditch that runs along the eastern border of Residence 1 receives runoff from upland agricultural property. The ditch appears to originate in the upland agricultural property but it is not clear where it discharges.[1]

During the WSDA inspection, two well water samples (kitchen tap) and a foliage sample were taken and analyzed for phenoxy herbicides[a] and glyphosate (an herbicide commonly known as Roundup®). Several of these herbicides were detected in the water samples but none were found in the foliage sample. On August 27, 1999, WSDA collected one soil sample from the drainage ditch located on the agricultural property north of Paradise Road and another from the same ditch where it runs across Residence 1. Analysis of these samples for phenoxy herbicides and glyphosate revealed only trace levels of glyphosate in one of the samples. The well at Residence 1 was re-sampled on September 21, 1999, along with two residential wells located on adjacent properties (Residences 2 and 3) to the west and east.[1] Discussions with residents indicate that all of these wells are greater than 100 feet in depth.

No public supply wells are located within a two-mile radius of Residence 1 while five public wells are within five miles (Figure 3). Four of these wells (one is inactive) are located approximately 3 miles to the northwest of Residence 1 and serve approximately 590 residents. One concerned resident noted that his private well was about 360 feet east of Residence 3. No information regarding the direction or speed of groundwater flow was located.

Table 1 presents the maximum levels of herbicides detected in the three drinking water wells tested during the WSDA investigation. The well at Residence 1 was sampled at the kitchen tap

[a] All analyses were performed by WSDA. The WSDA phenoxy herbicide scan also detects non-phenoxy herbicides of similar structure such as bromoxynil (substituted phenol), clopyralid (picolinic acid) and triclopyr (pyridine).

while samples from Residences 2 and 3 came from outside taps. Each well sampling event consisted of an initial draw and another sample taken after three minutes of purging (see Appendix A for complete results of well samples). Detection limits varied between samples which could explain the differences between initial and purged samples. The maximum pesticide levels detected for each well are given below in Table 1.

Table 1. Maximum levels of herbicides detected in three private drinking water wells located on Paradise Road near Spangle, Washington in parts per billion (ppb).

Contaminant	Residence 1	Residence 2	Residence 3
2,4-Dichlorophenoxyacetic acid (2,4-D)	120	120	120
Bromoxynil	60	ND	ND
Clopyralid	30	ND	ND
MCPA (2-methyl-4-chlorophenoxyacetic acid)	62	60	ND
MCPB (2-methyl-4-chlorophenoxybutyric acid)	50	ND	ND
Triclopyr	1	1	1.2

Note: Complete sampling results are given in Appendix A.
ND = not detected.

Maximum Contaminant Level (MCL)

The MCL is a regulatory limit set by the Environmental Protection Agency (EPA) for contaminants in *public* drinking water. If an MCL is exceeded, regulatory action is required under the Safe Drinking Water Act. MCLs are not always strictly health based but can consider technological or economic feasibility. The Washington State Department of Health (DOH) regulates public drinking water supplies in Washington State.

The contaminants listed in Table 1 are all herbicides commonly used in the agriculture industry. Of all the contaminants detected, only 2,4-dichlorophenoxyacetic acid (2,4-D) has a regulatory standard for public drinking water supplies.[2] These standards, known as maximum contaminant levels (MCLs), are not enforced for private drinking water wells but are useful for comparison. The maximum level of 2,4-D detected (120 ppb) in each of the three wells samples exceeds the MCL of 70 ppb. Based on this preliminary comparison, residents were verbally advised not to use these wells as a source of drinking water until a written health consultation could be prepared.

Discussion

The following section discusses the potential for adverse health effects that could result from exposure to the contaminants found in drinking water wells on Paradise Road. Exposure was evaluated based on chronic ingestion of contaminated drinking water. Inhalation and dermal exposure is not considered to be significant for these contaminants because of their chemical and physical properties.[3,4] As shown in Appendix A, the primary contaminants appear to be 2,4-D and

2-methyl-4-chlorophenoxyacetic acid (MCPA). Bromoxnyil and clopyralid were detected in only one sample from one well. Analysis of other samples taken from this same well did not detect these two herbicides. Triclopyr was found in each of the three wells but only at trace amounts.

Summary

The levels of herbicides detected in Paradise Road wells represent some risk for adverse health effects over long periods of exposure. Although available toxicity data suggest that adverse health effects from such exposure are unlikely, the presence of multiple pesticides, some of which exceed health guidelines, is cause for concern.

Non-cancer Effects

Oral Reference Dose (RfD)
An oral reference dose (RfD) is a level of exposure to chemicals below which non-cancerous effects are not expected. RfDs are set by the Environmental Protection Agency (EPA).

Doses were estimated for each contaminant of concern based on the assumption of a young child drinking contaminated water for several years (see Appendix B for dose calculations). These doses were then compared with their respective oral reference dose (RfDs). The dose calculated for MCPA is approximately 7-fold higher than its respective RfD. The doses calculated for the other contaminants do not exceed their RfDs although 2,4-D does exceed its MCL.[5,6] Clopyralid is the only contaminant that does not have an RfD with which to compare the estimated dose.

The RfD for MCPA is based on liver and kidney toxicity in dogs given at doses that were 220-fold higher than the dose estimated above for Paradise Road residents. This same study found no effects in dogs at doses 40-fold higher than the dose estimated for Paradise Road residents.[5] Furthermore, in more prolonged studies in dogs and in several studies in rats including a 2-generation reproductive study, even higher dose levels failed to produce toxicity.[5] Therefore, current levels of MCPA in drinking water are considered to be only of minimal risk for non-cancer adverse health effects. Exposure to the other herbicides is of less concern since the estimated doses are below their respective RfDs.

In order to assess the combined exposure from each herbicide detected in drinking water, the estimated doses for each of the contaminants noted above were added and compared with a "combined RfD." This combined dose did not substantially add to the risk estimated from exposure to MCPA alone. This approach is considered to be valid for contaminants that have the same toxic effect. The RfDs for MCPA, 2,4-D, MCPB and triclopyr are based on liver and kidney effects.[5] The RfDs for bromoxynil and clopyralid are based on the highest doses in studies that found no effects.[5,7]

Cancer Effects

EPA has determined that bromoxynil is a Group C possible human carcinogen while 2,4-D and triclopyr are not classifiable as to their potential to cause cancer (Group D).[5,6,8] Clopyralid has not been classified as to its carcinogenic potential although there is one rat study that suggests it is not carcinogenic.[7] No EPA cancer assessment for MCPB and MCPA could be located. The International Agency for Research on Cancer (IARC) has classified the chlorphenoxy herbicides as probably carcinogenic to humans (Group 2B) based on limited evidence in humans and inadequate evidence in animals.[9] Of the herbicides detected in Paradise Road wells, 2,4-D, MCPA and MCPB are considered chlorphenoxy herbicides. It is important to note that while some of the data cited in the IARC cancer assessment of chlorphenoxy herbicides included 2,4-D and MCPA, a significant consideration was also given to 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) exposure. Use of 2,4,5-T in the U.S. was banned by EPA in January 1985 and it was not detected in any Paradise Road wells.

The data supporting the classification of bromoxynil as a possible human carcinogen was used by EPA to derive a cancer slope factor.[9] This factor is a measure of cancer potency and indicates that a *very low* cancer risk exists for a person exposed to 60 ppb bromoxynil in drinking water over a 30-year period. However, bromoxynil was detected in only one sample (Residence 1), and not in subsequent samples from this same well. Therefore, this estimate applies only for persons drinking water from the well at Residence 1 and is dependent on subsequent sampling.

Cancer Risk

Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this theoretical risk are defined below as the number of excess cancers expected in a population over a lifetime:

Term		# of Excess Cancers
moderate	is approximately equal to	1 in 1,000
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000
insignificant	is less than	1 in 1,000,000

The carcinogenic potential of 2,4-D has been studied extensively with conflicting results. One study in animals given high doses of 2,4-D showed an increase in brain cancer at the highest dose.[10] Another study of dogs exposed to 2,4-D that had been applied to residential lawns reported an increase in canine malignant lymphoma.[11] However, no controlled laboratory studies in dogs, rats or mice have shown increases in lymphoma following exposure to 2,4-D. More recent long-term studies of rats and mice exposed to 2,4-D showed no evidence of carcinogenicity.[7,8]

Increased incidence of non-Hodgkins lymphoma and soft-tissue sarcoma have been reported in workers exposed to 2,4-D. However, other studies that looked for these same types of cancer have found no association with exposure to these herbicides.[7,8] In general, human epidemiological studies are conflicting while most animal studies show no evidence of carcinogenicity associated with 2,4-D exposure.

Other Sources of Exposure

Pesticides in food are often a contributing source when assessing overall exposure to pesticides. The herbicides detected in Paradise Road wells are found in food at varying amounts. Current EPA pesticide registration guidelines require that aggregate food exposure be estimated for pesticide residues in food. This aggregate dose from food is then compared to the RfD. The estimated doses of each herbicide detected in Paradise Road wells are given in Table 2 as a percent of its respective RfD along with the percent contribution form residues in food.[6,7,8,12] As is evident, MCPA is the most significant contaminant in Paradise Road wells with respect to the potential for non-cancer health effects. 2,4-D is the only herbicide that has a significant exposure from food.

Table 2. Pesticide exposure from Paradise Road drinking water wells versus food

Herbicide	Percent of RfD from Well	Percent of RfD from Food
2,4-Dichlorophenoxyacetic acid (2,4-D)	65	26
Bromoxynil	16	<1
Clopyralid	0.3	0.8 - 4.2
MCPA (2-methyl-4-chlorophenoxyacetic acid)	680	NA
MCPB (2-methyl-4-chlorophenoxybutyric acid)	27	NA
Triclopyr	0.01	0.81 - 2.65

NA = not available

Another possible source of pesticide exposure for residents living near treated fields is from drift during application. Drift is dependant upon several factors including type of application, type of pesticide and weather. Aerial applications are generally the biggest concern for drift. Growers are required to follow label requirements and WSDA regulations that are in place to limit pesticide drift. While it is difficult to quantify the alternate sources of exposure to these herbicides, such a contribution to overall exposure is of concern.

Exposure and Children

The potential for exposure and subsequent adverse health effects are often increased for young children as opposed to older children or adults. For example, children drink more water per body weight than do adults. In addition to the potential for higher exposures of young children, the risk of adverse health effects is also increased. ATSDR and DOH recognize that children are susceptible to developmental toxicity that can occur at levels much lower than those causing other types of toxicity. The analysis above is considered to be protective of children since developmental toxicity studies in animals showed effects only at high doses similar to those used in deriving the RfD.[5,6,7,8]

Filter Devices

Residents requested information regarding filtration systems that would be effective at removing the contaminants found in their wells. There are many filtration devices on the market that fall into three main categories: carbon filters, fiber filters and reverse osmosis. Of these three types carbon filtration and reverse osmosis may be effective at removing phenoxy herbicides. These systems can be installed at the point-of use (i.e., faucet) or at the point-of-entry into the house in which case all of the water entering the house plumbing is treated.

Proper maintenance of filtration devices is essential. Under normal use, carbon filters will need to be changed regularly to maintain an effective contaminant removal efficiency and reduce the accumulation of bacteria. In addition, carbon filters can be fouled by high mineral concentrations associated with water hardness. Therefore, carbon filtration devices will need to be replaced more frequently if hard water fouling is evident.

DOH does not make recommendations for one system over another. However, DOH does recommend that water treatment devices be certified by testing organizations that meet the requirements of the American National Standards Institute (ANSI). Two organizations that currently certify water filtration devices and meet ANSI standards are NSF International (formerly the National Sanitation Foundation) and Underwriters Laboratories Inc (UL). Products certified by one of these institutions will display an NSF or UL certification mark. NSF International has a certified product listing on the Internet at *www.nsf.org.* Underwriters Laboratories also has an Internet site at *www.ul.com* where a certified products listing can be ordered.[b]

Herbicides in Groundwater

The herbicides found in wells along Paradise Road are not often detected in groundwater despite their widespread use on grain crops in Washington State, especially 2,4-D. A survey of 255 wells sampled in the central Columbia plateau found 2,4-D in only 4 wells (2%), clopyralid in 1 well (1%) while bromoxynil and MCPA were not detected.[13] It is important to note that the Paradise Road wells are all reportedly finished at depths exceeding 100 feet. Generally, the deeper the well the more protection it has from surface contamination. The fact that these infrequent groundwater contaminants have reached these depths is unusual and indicates that other more common contaminants such as nitrate and bacteria may also be present.

[b] A good summary of drinking water filtration devices from the Department of Environmental Design, University of Missouri-Columbia is available on the Internet at *http://muextension.missouri.edu/xplor/hesguide/houseeq/gh4864.htm.* If you would like more information regarding home drinking water treatment devices, please contact Robert Duff toll-free at 877-485-7316 or 360-236-3371.

Conclusions

A public health hazard exists for residents drinking water from Paradise Road wells that are contaminated with phenoxy herbicides. Although adverse health effects are unlikely at current levels, limited sampling indicates that levels are high enough to be of concern. Exposure through inhalation and dermal contact during showering and other non-drinking water uses is not expected to contribute significantly to overall exposure.

The herbicides detected in Paradise Road wells are not frequently found in groundwater indicating that the aquifer in this area may be unusually susceptible to contamination. These herbicides are present in three wells that are reportedly all greater than 100 feet in depth and up to one mile apart indicating significant migration of these contaminants in groundwater. Other wells in the area may be at risk for herbicide contamination as well as other more common contaminants such as nitrate and bacteria.

Recommendations

The three private wells along Paradise Road that are contaminated with herbicides should not be used as a drinking or cooking source. Other uses such as showering, bathing and clothes/dish washing are not considered to be a substantial source of exposure. Filter devices should meet previously discussed standards before filtered water is used for drinking or cooking. At least one filtered sample should be tested for the herbicides of concern to confirm an adequate removal efficiency.

The Washington State Department of Ecology should characterize the groundwater contamination in the Paradise Road area. Investigations should attempt to determine the source, extent and likely migration patterns of contaminants in groundwater.

A well survey should be conducted along Paradise Road in the general area of the contaminated wells. The three wells already identified with contamination should be re-sampled and analyzed for herbicides using EPA certified methods (e.g., EPA 8150). Any other drinking water wells identified in this area should also be sampled and analyzed for herbicides.

Contaminated wells in the area should be sampled quarterly for a period of at least one year to determine whether seasonal influences are impacting herbicide levels in these wells. In addition, wells found to be contaminated with herbicides should also be tested for nitrate and bacteria.

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Figure. 1. Site Location Map

Figure. 2. Site Diagram (adapted from Ref 1.)

Figure 3. Public Supply Wells in the Vicinity of Paradise Road near Spangle, Washington.

APPENDIX A: Test Results for Paradise Road Drinking Water Wels

Table A1. Herbicides detected in samples taken from private drinking water wells located along Paradise Road near Spangle, Washington (parts per billion).

Contaminant	7/17/99		9/21/99					
	Residence 1		Residence 1		Residence 2		Residence 3	
	Initial Draw	3' Purge[a]	Initial Draw	3' Purge	Initial Draw	3' Purge	Initial Draw	3' Purge
2,4-D (2,4-Dichlorphenoxyacetic acid)	ND	40	120	11	120	96	120	110
Bromoxynil	ND	60	ND	ND	ND	ND	ND	ND
Clopyralid	ND	30	ND	ND	ND	ND	ND	ND
MCPA (2-methyl-4-chlorophenoxyacetic acid)	40	40	62	ND	60	ND	ND	ND
MCPB (2-methyl-4-chlorophenoxybutyric acid)	ND	50	ND	ND	ND	ND	ND	ND
Triclopyr	ND	ND	1	1	1	0.83	1.1	1.2

a = Detections limits on the purged sample were lower compared with the initial draw.
ND = not detected.

APPENDIX B: Exposure Dose Calculations

This appendix provides the exposure assumptions and calculated doses used to estimate health risks associated with exposure to contaminants of concern in drinking water. The dose estimates for each of these pathways are presented in the Discussion section of the document. The reader should be aware that maximum concentrations are used to calculate these doses. This represents a worst-case scenario that may overestimate actual exposure. Non-cancer dose calculations assumed a five-year exposure of a child from birth through 5 years of age. Cancer dose calculations assumed a 30-year exposure of a child growing to adulthood. Only ingestion of drinking water was considered in these dose calculations as inhalation and dermal exposure were estimated to be less than 10% of overall exposure.

Ingestion

Non-cancer

$$ID_{0\text{-}5} = \frac{C \times IR_{0\text{-}5} \times CF \times EF_{0\text{-}5} \times ED}{BW_{0\text{-}5} \times AT_{\text{non-cancer}}}$$

Cancer

$$\sum (ID_{0\text{-}5,6\text{-}15,16\text{-}30} \times CSF)$$

$$ID_{0\text{-}5} = \frac{C \times IR_{0\text{-}5} \times CF \times EF_{0\text{-}5} \times ED}{BW_{0\text{-}5} \times AT_{\text{cancer}}}$$

$$ID_{6\text{-}15} = \frac{C \times IR_{6\text{-}15} \times CF \times EF_{6\text{-}15} \times ED}{BW_{6\text{-}15} \times AT_{\text{cancer}}}$$

$$ID_{16\text{-}30} = \frac{C \times IR_{16\text{-}30} \times CF \times EF_{16\text{-}30} \times ED}{BW_{16\text{-}30} \times AT_{\text{cancer}}}$$

Ingestion Exposure Assumptions

ID	=	Ingested Dose (mg/kg-day)
C	=	Concentration in drinking water (ppb or *u*g/l)
$IR_{0\text{-}5}$	=	Ingestion Rate = 0.87 l/day
$IR_{6\text{-}15}$	=	Ingestion Rate = 0.97 l/day
$IR_{16\text{-}30}$	=	Ingestion Rate = 1.4 l/day
CF	=	Conversion Factor = 0.001 ppm/ppb
EF	=	Exposure Frequency = 350 days/year
$ED_{0\text{-}5}$	=	Exposure Duration = 5 years
$ED_{6\text{-}15}$	=	Exposure Duration = 10 years
$ED_{16\text{-}30}$	=	Exposure Duration = 15 years
$BW_{0\text{-}5}$	=	Body Weight = 15.3 kg
$BW_{6\text{-}15}$	=	Body Weight = 41.1 kg
$BW_{16\text{-}30}$	=	Body Weight = 71.8 kg
$AT_{\text{non-cancer}}$	=	Averaging Time = 1825 days
AT_{cancer}	=	Averaging Time = 25550 days

Non-Cancer Dose Calculations

Receptor Population	Media	Contaminant	Maximum Concentration (ppb)	Exposure Route	Estimated Dose (mg/kg-day)	RfD/MRL (mg/kg-day)	Hazard Quotient
Child	Drinking water	2,4-D (2,4-Dichlorophenoxyacetic acid)	120	Ingestion [a]	7.2E-03	1.0E-02	0.7
		Bromoxynil	60		3.3E-03	2.0E-02	0.2
		Clopyralid	30		1.6E-03	5.0E-01	0.003
		MCPA (2-methyl-4-chlorophenoxyacetic acid)	62		3.4E-03	5.0E-04	7
		MCPB (2-methyl-4-chlorophenoxybutyric acid)	50		2.7E-03	1.0E-02	0.3
		Triclopyr	1.2		6.5E-05	5.0E-02	0.001

a = Inhalation and dermal exposure are expected to contribute less than 10% of ingestion exposure.

Exposure Assumptions: *Child* - IR = 0.9 l/day, ED = 5 years, EF = 350 days/year, BW = 15.3 kg, $AT_{non\text{-}cancer}$= 1825 days

Cancer Dose Calculations

Receptor Population	Media	Contaminant	Maximum Concentration (ppb)	Exposure Route	Estimated Dose (mg/kg-day)	Cancer Potency Factor $(mg/kg\text{-}day)^{-1}$	Cancer Risk	EPA Cancer Group
Child Adult	Drinking water	Bromoxynil	60	Ingestion [a]	6.7E-04	1.03E-01	6.9E-05	C

a = Inhalation and dermal exposure are expected to contribute less than 10% of ingestion exposure.

Exposure Assumptions: *Child* - IR = 0.87 l/day, ED = 5 years, EF = 350 days/year, BW = 15.3 kg, $AT_{non\text{-}cancer}$= 25550 days

Older Child - IR = 0.97 l/day, ED = 10 years, EF = 350 days/year, BW = 41.1 kg, $AT_{non\text{-}cancer}$= 25550 days

Adult - IR = 1.4 l/day, ED = 15 years, EF = 350 days/year, BW = 71.8 kg, $AT_{non\text{-}cancer}$= 25550 days